THE EXPERIMENTAL STUDY ON THE RELATIONSHIP BETWEEN THE GASTROINTESTINAL MOTILITY AND THE ABSORPTION OF FAT AFTER GASTROINTESTINAL SURGERY, USING I131 LABELED OLIVE OIL

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by

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NTRODUCTION

The problem of nutrition in the surgical field is very important as it is one of the essential factors contributing to the progress of surgery as well as the surgical technic and anesthesia. Recently, the major gastrointestinal operation, which was difficult formerly, is performed with comparative ease and safe owing to the proper nutritional management and medical treatment. The problem of early feeding through mouth and gastric tube following gastrointestinal operation is especially regarded as a matter of great importance and invites discussions on the time to start the postoperative feeding.

In 1957, studing the relationship between the gastrointestinal motility and absoption after the gastrointestinal surgery, Asano[1] and Watanabe[2] reported that the absorption of radioactive inorganic phosphorus had some correlation to the gastrointestinal motility, but radioactive inorganic sodium was easily absorbed without any relation to it. Later on, using I^{131} labeled casein, Naito[3] made it clear that protein absorption had relation to the gastrointestinal motility after gastrointestinal surgery, and referred to the influences of anesthesia upon the gastrointestinal motility and protein absorption. This study gave a new information on the problem of the early feeding of protein through mouth and tube following gastrointestinal surgery.

As the study of metabolism advanced, various views are taken about nutrition. Until Devel and his collaborators[4] clarified new information about the essential fatty acid, nothing had been understood about the metabolism of fat, except that it was one of nutrients which had the highest caloric density and contained rich fat-soluble vitamins. From their work, further roles of fat in the diet was recognized; not only it checks and improves the progress of fat deffciency symptomes, but also it relates to important physiological functions such as growth, sex maturation, pregnancy, lactation and work capasity. Therefore, it must be very important to take proper quantity of fat daily, which contains essential fatty acid and fatsoluble vitamins. In fact the importance of early feeding of fat is emphasized in the surgical field

especially to the nutrition of the postoperative patients. And intravenous administration of fat emulsion has been studied by many investigators.[5),6),7)]

In JAPAN, Y. MIYAKAWA and I. MIYAKAWA[8)] reported for the first time the experimental study on intravenous administration of fat. Later, the intravenous administration of water soluble fatty acid to the postoperative patients has been studied for the last few years, but the administration is not generally applied for clinic because of its evil reaction. So it is very significant to study the problem of early fat feeding through mouth and tube following gastrointestinal surgery. In 1958, KOMI[9)] reported in details the results of the clinical study on tube feeding after the gastrointestinal operation, using very effective fat emulsion as postoperative nutrition. HOSAKA[10)] states the interesting facts that the ileocecal resection is not dangerous at all from the viewpoint of the absorption of the fat, so long as mesenterium is kept as wide as possible as its extensive resection may disturb the recovery of the function of fat absorption and give rise to the abnormal motility of gut.

Last year, using I^{131} labeled fat, NAKAYAMA and his WORKERS[11)] reported the results of their investigation on digestion and absorption of fat after various kind of operations about the gastrointestine and its neibouring organs. TOMODA[12)] also reported many results from the clinical study on digestion and absorption of fat in totally gastrectomized patients. But no report is found on the relationship between fat absorption and the gastrointestinal motility after gastrointestinal surgery. The purpose of this paper is to investigate experimentally the relationship between the gastrointestinal motility and the function of fat absorption from the gastrointestinal tract after gastrojejunostomy, gastrectomy and ligation of common bile duct with and without cholecystostomy, in addition, to study the influence of general anesthesia by ether upon fat absorption and the gastrointestinal motility.

MATERIAL AND METHOD

Adult mongrel dogs were used for the experiment. To study fat absorption, the test meal was prepared which contained 0.5 ml of olive oil added 100 μc of I^{131} labeled olive oil per kilogram of dog's weight. Radioactive iodine labeled olive oil was synthesized by the modification of HOFFMANN'S[13)] and HAMILTON'S method,[14)] which was reported previously by us.[15)] Dogs were fasted for 24 hours before the operation and the administration of the test meal, and most of them were performed the gastrointestinal operation under ether anesthesia by OMBREDANNE'S apparatus, but few were performed upper abdominal vertical incision under the local anesthesia with 0.5% novocain solution. The test meal was administered through the rubber tube.

To observe the gastrointestinal motility, the plastics window was attached on the abdominal wall of female dog, which was devised originally by TANAKA.[16)] This method is very convenient to observe the gastrointestinal motility under quite physiological condition during the experiment. Phenor red was used as marker in order that the transport of the intestinal contents could be observed by the distribution of Phenor red along the intestinal wall. 1-7 frequency/min. of the peristaltic

movement of the gastrointestine were expressed as (+); 8-12 frequency/min. as (++); and more than 13 frequency/min. as (+++).

Blood samples were taken 5, 10, 15, 30 min. and 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 5.0, 6.0, 8.0, 10.0, 12.0, 15.0, 18.0, 21.0, 24.0 hour after administration of the test meal in order to analyse blood radioisotope contents, and using 1.0 cc of venous blood, their blood radioactivity was calculated by GEIGER MÜLLER tube. The total blood volum assumed to be 7.7 per cent of dog's weight and the radioisotope contents in the total blood volum was caluculated and expressed as percentage of ingested radioisotope of the test meal. All samples were counted for sufficient time to give statical accuracy of the data.

RESULTS

1. Preliminary experiment

It is necessary for investigating fat absorption after gastroinstinal surgery to know the speed and quantity of fat absorption from different regions of normal dogs and at the same time to study the influence of anesthesia and enzyme inhibitor upon fat absorption. The following experiments were carried out as preliminary experiment on normal dogs.

A. Absorption from the gastrointestine of normal dogs

a) Absorption from the gastrointestinal tract during the fasting time

Fifteen control tests were carried out on healthy dogs of both sexes to get normal control value of blood radioisotope contents after administration of the test meal containing I^{131} labeled olive oil. The amount of radioisotope entering into blood was hardly calculated until 15 min. after administration. Then it increased rapidly and reached the maximum after five or six hours. The maximum value was about 11.5 per cent. After that, the value of radioisotope blood contents decreased gradually to about half of the maximum value 24 hours after administration. (Fig. 1)

b) The influence of monojodo-acetic acid on absorption and the gastrointestinal motility

About fat digestion and absorption it is generally accepted that all fat is completely hydrolyzed by pancreatic lipase to glycerol and fatty acid, and glycerol and fatty acid are resynthesized a fat molecule in the wall of the gut before entering into the lacteals. In this chemical process, monojodoacetic acid and phlorrhizin are recognized as enzyms inhibitors of phosphorylation. This test was carried out on healthy dogs to see the influence of monojodoacetic acid upon digestion and absorption of fat.

The test meal containing 0.01 mol of monojodoacetic acid was administered into the stomachs of five dogs. Among them, two were operatively fixed the plastics window on the abdominal wall four days before this experiment to observe the gastrointestinal motility. Except immediately after administration, fat absorption was inhibited less than a half of normal control, and the maximum value of radioisotope blood level was under 5% in spite of the normal peristaltic movements of the gut. (Fig. 2) The influence of monojodoacetic acid upon the gastrointestinal

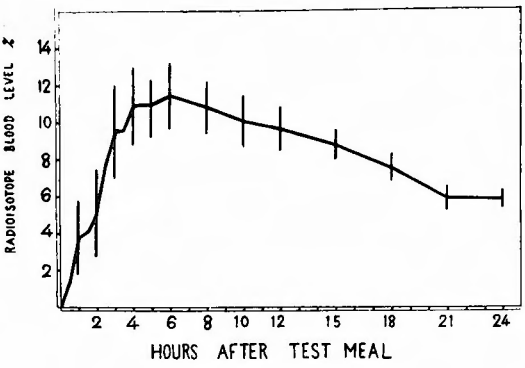

Fig. 1 Average normal curve with standard deviation at points indicated

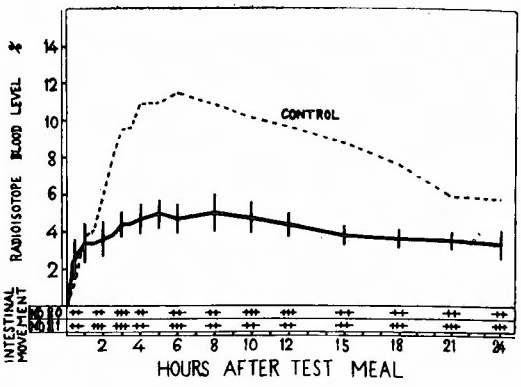

Fig. 2 Graph showing the influences of monojodoacetic acid on absorption, and the gastrointestinal motility. Average curve showing standard deviation at points indicated.

motility was not described minutely in this paper, as it was fully reported by Naito.[3)]

B. Absorption from the different regions of the gastrointestine

a) Absorption from the stomach when the pylorus was occluded

In order to evaluate the gastric function of digestion and absorption of fat, this test was carried out on five dogs occluded pylorus with PETZ's clamp under local anesthesia with 0.5% novacain solution. Then the test meal was ingested into the stomach of the dogs. There was almost complete absence of digestion and absorption of fat revealed by blood radioisotope contents during 24 hour-period of the test. The results of this study are shown in Fig. 3.

b) 1) Absorption from the intestinal tract when the test meal was directly administered into the duodenal canal

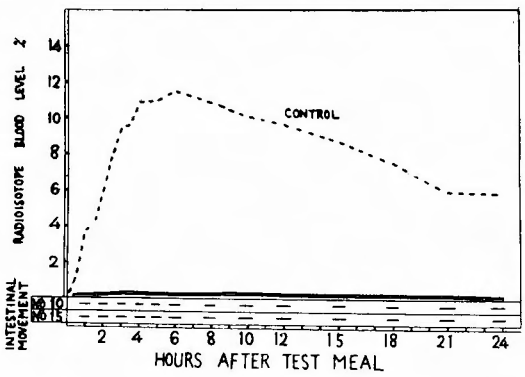

Fig. 3 Graph showing comparison in curve of blood isotope per cent in normal and pylorus occluded.

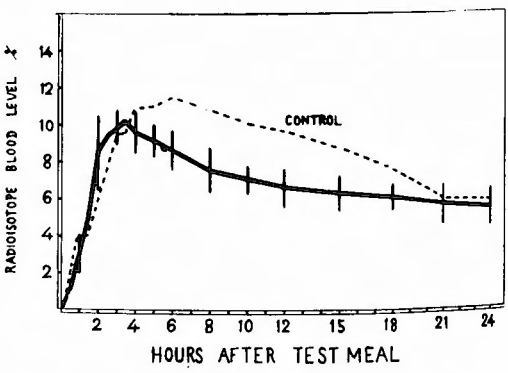

Fig. 4 Graph showing the absorption curve when the test meal was administered directly into the duodenal canal and average curve showing standard deviation at points indicated

In order to study the absorption from the intestinal tract, the test meal was directly administered into the duodenal canal of five dogs. For 3.5 hours after administration, the value of radioisotope blood contents increased more rapid than normal control, and 3.5 hours after it reached the maximum, and after that it decreased comparatively rapidly. The maximum value was about 10% and it was lower than control value. The results of this experiment are shown in Fig. 4.

2) The influence of monojodoacetic acid on the absorption from the intestinal tract and the gastrointestinal motility when the test meal was directly administered into the duodenal canal

The test meal added 0.01 mol solution of monojodoacetic acid was directly administered into the duodenal canal. For 2 hours after administration, radioisotope blood level was higher than that of normal control, but after that it showed remarkable diminution though the peristaltic movement of the gut was active as normal. The results of this experiment are shown in Fig. 5. As ASANO[1] and NAITO[3] reported, the inhibition of fat absorption was also confirmed using I^{131} labeled olive oil.

C. The influence of anesthesia upon absorption and the gastrointestinal motility

Anesthesia has played more and more an important part in surgical field. Many operations which were formerly incapable can be performed easely and safely under general anesthesia. But general anesthesia is considered to have much influence on a living body. This experiment was carried out on healthy dogs to study the influence of general anesthesia on the gastrointestinal motility and fat absorption.

a) Absorption from the gastrointestine and the gastrointestinal motility under anesthesia

Five dogs were anesthesized with OMBRÉDANNE's apparatus until the third stage of anesthesia, when the test meal was rapidly administered into the stomachs.

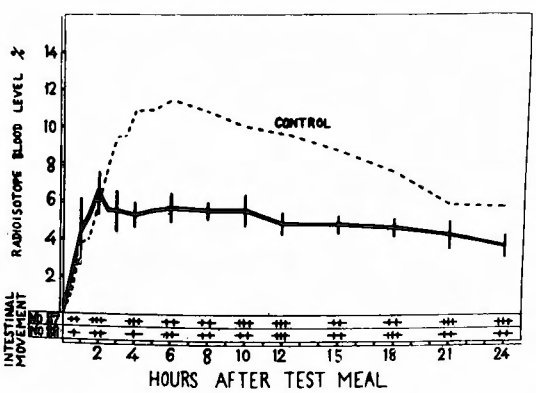

Fig. 5 Graph showing the influences of monojodoacetic acid on absorption when the test meal was directly administered into the duodenal canal, and the gastrointestinal motility. Average curve showing standard deviation at points indicated.

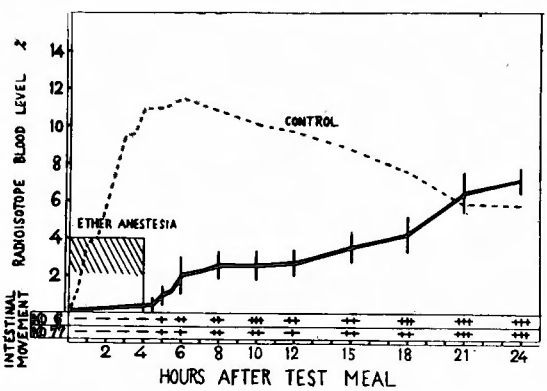

Fig. 6 Graph showing the influences of anesthesia upon the gastrointestinal motility and absroption. Average curve showing standard deviation at points indicated.

Among them, two were fixed the abdominal windows through which the gastrointestinal motility could be seen. In this test the absorption curve showed a particular trait. There were almost complete absence of both absorption and the gastrointestinal motility during four hours peroid of anesthesia. After the anesthesia, the absorption of fat was extremely restrained for a long time even after the peristaltic movement of the gut was completely recovered. The maximum value was about 7 per cent 24 hours after ingestion. The results of this experiment are shown in Fig. 6. The gastrointestinal motility observed in details in No. 6 and No. 11 was as follows:

Hours after test meal	Gastrointestinal motility
5′	Gastrointestinal motility was not observed.
10′	
15′	Tonus of gastrointestine was atonic.
30′	Capillary venous stasis of the intestinal serosa was
1.00′	observed. Fluid of exudation was not seen in No. 6
2.00′	and No. 11.
3.00′	
4.00′	Adhesion of peritoneum was not seen in both.
4.10′	Gastrointestinal motility was not yet seen, but capil-
4.20′	lary venous stasis disappeared. Stomach was still relaxed.
4.30′	Spastic and tonic peristaltic movement of small bowel was observed. It was irregular and easily weary.
5.00′	Peristaltic movement was almost recovered in No. 6, but sometimes irregular movement appeared. In No. 11 it was completely recovered.
5.30′	Gastrointestinal motility was completely recovered and active. 12 frequency/min. in No. 6, and 13 frequency/min. in No. 11.

After the anesthesia the gastrointestinal motility was gradually recovered. At first, the pendulous movement appeared, next spastic and tonic movement was seen, and then the rhythmic peristaltic movement was observed through the abdominal window.

b) Absorption from the intestinal tract under anesthesia when the test meal was directly administered into the duodenal canal

It was supposed that the test meal was stagnated in the stomach during four hours period of anesthesia as the gastrointestinal motility was checked for the period. So the test meal was directly administered into the duodenal canal, but absorption was about 1 per cent during anesthesia. Fat absorption was inhibited for a long time after anesthesia as previous experiment, though the peristaltic movement recovered. 14 hours after, it recovered to a considerable degree and kept almost fixed value. The results of this study are shown in Fig. 7.

II. Absorption and the gastrointestinal motility after gastrojejunostomy

After the abdomen had been opened by upper abdominal vertical incision, pylorus was obstructed by PETZ's clamp and isoperistaltic anastomosis was done between the stomach and the jejunum 30-40 cm from the ligament of Treitz. Then BRAWN's entero-entero anastomosis was performed.

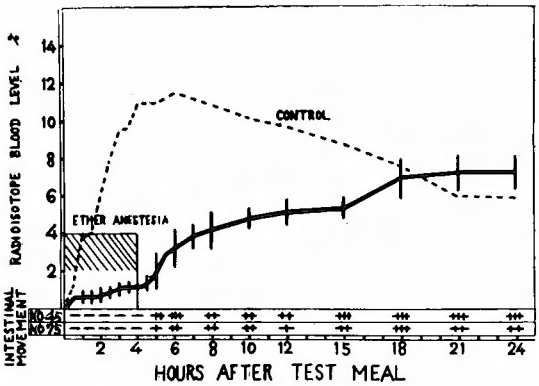

Fig. 7 Graph showing the influences of anesthesia upon the gastrointestinal motility and absorption when the test meal was administered into the duodenal canal. Average curve standard deviation at points indicated.

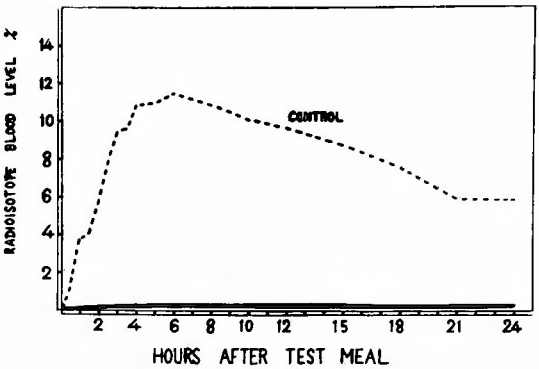

Fig. 8 Graph showing comparison in curve of blood isotope percent in normal and gastrojejunostomized dogs immediatly after operation, and the intestinal motility. Average curve of controls is broken line.

A. Absorption and the gastrointestinal motility immediately after gastrojejunostomy

When the gastrojejunostomized dogs were awakened from anesthesia, 100 μc of I^{131} labeled olive oil was administered into the stomachs through the rubber stomach tubes. During 24 hours period of the test, there was almost complete absence of absorption same as the pylorus was occluded. From this result it is supposed that the test meal was stagnated in the stomach for the standstill of the gastrointestinal motility. This results are shown in Fig. 8 and in Table 1.

Table 1 Radioisotope blood level (%) immediately after gastrojejunostomy

Time	No. 9 8.3kg Blood level (%)	No. 11 8.1kg Blood level (%)	No. 16 7.2kg Blood level (%)
5′	0.00	0.00	0.00
10′	0.06	0.06	0.00
15′	0.06	0.02	0.01
30′	0.05	0.04	0.03
1. 0′	0.16	0.12	0.06
1.30′	0.21	0.11	0.05
2. 0′	0.22	0.11	0.06
2.30′	0.28	0.10	0.08
3. 0′	0.29	0.14	0.09
3.30′	0.27	0.15	0.12
4. 0′	0.36	0.10	0.10
5. 0′	0.42	0.17	0.10
6. 0′	0.55	0.15	0.13
8. 0′	0.47	0.15	0.15
10. 0′	0.25	0.13	0.16
12. 0′	0.13	0.10	0.17
15. 0′	0.15	0.10	0.15
18. 0′	0.20	0.10	0.14
21. 0′	0.14	0.10	0.10
24. 0′	0.10	0.11	0.10

Throughout the test the peristaltic movement was not observed except occasional pendelous movement of the small bowel.

B. Absorption and gastrointestinal motility 4 days after gastrojejunostomy

Gastrojejunostomized dogs were carefully fed by postoperative diet for 4 days after operation. Immediately after administration of the test meal, the value of radioisotope blood content was very low compared with control, and the maximum value was under 4 per cent. The peristaltic movement of the gastrointestine was irregular and not yet active. The results of this experiment are shown in Fig. 9 and in Table 2.

Table 2 Radioisotope blood level (%) and the motility of the small bowel 4 days after gastrojejunostomy

	No. 17 dog 9.6kg	
Time	Blood level (%)	Gastrointestinal motility
5′	0	Gastrointestinal tonus was slightly relaxed, and irregular and weary peristaltic movement was observed.
10′	0.05	
15′	0.12	
30′	0.10	Pendelous movement was seen but not active. Fluid of exudation was seen a little but bleeding was not.
1. 0′	0.20	
1.30′	1.1	
2. 0′	1.2	
2.30′	1.3	Peristaltic movement was regular but not active and easily fatigued. Congestion and stasis of vesseles were not observed.
3. 0′	1.3	
3.30′	1.3	
4. 0′	1.3	
5. 0′	1.3	
6. 0′	1.4	Peristaltic movement of small bowel was not active and the movement has long intervals. Sometimes, spastic and tonic movement was seen.
8. 0′	2.5	
10. 0′	2.5	
12. 0′	2.5	
15. 0′	2.9	Fluid of exudation was still observed a little.
18. 0′	3.1	
21. 0′	3.2	Adhesion of peritoneum was not observed. Tonus of stomach was still hypotonic.
24. 0′	3.6	

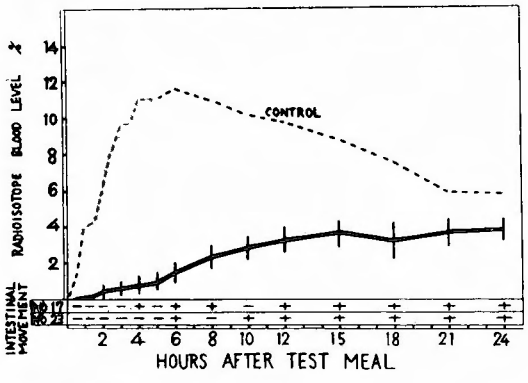

Fig. 9 Graph showing comparison in curve of blood isotope percent in normal and gastrojejunostomized dogs four days after operation, and the intestinal motility.

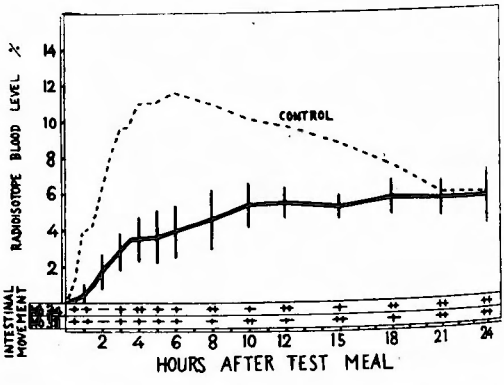

Fig. 10 Graph showing comparison in curve of blood isotope percent in normal and gastrojejunostomized dogs a week after operation, and the intestinal motility.

C. Absorption and the gastrointestinal motility a week and two weeks after gastrojejunostomy

Absorption and the intestinal motility were not yet completely recovered one week after operation. Two weeks after, the gastrointestinal motility was very active, but the maximum value of radioisotope blood content was lower than control. After two weeks, the time required to reach the maximum level was shortened

Table 3 Radioisotope blood level (%) and the gastrointestinal motility a week after gastrojejunostomy

		No. 38 dog 13.1kg
Time	Blood level (%)	Movement of the intestine and the stomach
5′	0	frequency/min.
10′	0.05	
15′	0.27	
30′	0.28	Regular peristaltic movement was observed, but it was faint and easily fatigued.
1. 0′	0.59	
1.30′	1.19	Exudation was not seen, and abnormal tonus of stomach and intestine was observed.
2. 0′	1.17	
2.30′	2.47	
3. 0′	2.51	
3.30′	2.40	
4. 0′	2.44	Regular peristaltic segmental movement was not active but incomplete movement was still observed.
5. 0′	2.11	
6. 0′	2.51	
8. 0′	3.70	G. M. 2 I. M. 5
10. 0′	5.03	G. M. 4 I. M. 9
12. 0′	5.00	G. M. 3 I. M. 5
15. 0′	5.00	G. M. 4 I. M. 8
18. 0′	6.25	G. M. 2 I. M. 5
21. 0′	6.60	G. M. 4 I. M. 10
24. 0′	7.53	G. M. 4 I. M. 10

G. M. gastric movement I. M. intestinal movement

Table 4 Radioisotope blood level (%) and the gastrointestinal motility 2 weeks after gastrojejunostomy

		No. 43 dog 6.8kg	
Time	Blood level (%)	Movement of the intestine	
5′	0	A, 8 B, 8	(frequency/min.)
10′	0.05		
15′	0.26	A, 7 B, 7	
30′	0.4	A, 8 B, 7	Regular peristaltic movement was observed. It was active but easily fatigued.
1. 0′	1.5	A, 7 B, 8	
1.30′	3.7	A, 6 B, 6	
2. 0′	4.6	A, 10 B, 10	Gastric tonus was not normal.
2.30′	5.0	A, 8 B, 8	
3. 0′	5.6	A, 10 B, 9	
3.30′	5.9	A, 9 B, 9	Ascites was not seen.
4. 0′	5.6	A, 8 B, 8	
5. 0′	5.6	A, 8 B, 8	
6. 0′	5.4	A, 11 B, 11	
8. 0′	5.7	A, 10 B, 10	
10. 0′	5.8	A, 11 B, 12	
12. 0′	5.5	A, 12	Peristaltic movement was fully recovered. It was active but spastic and tonic movement was also observed.
15. 0′	5.0	A, 12 B, 11	
18. 0′	5.0	A, 10 B, 11	
21. 0′	4.9	A, 11 B, 12	
24. 0′	5.2	A, 12 B, 12	

Point A is 30 cm distal from the TREITZ's ligament
Point B is 95 cm distal from the TREITZ's ligament

compared with after a week. Absorption and the gastrointestinal motility was recovered gradually as time elapsed after operation. The results of these tests are shown in Fig. 10 and 11, and the experimental data are shown in Table 3 and 4.

D. Absorption and the gastrointestinal motility 3 weeks after gastrojejunostomy

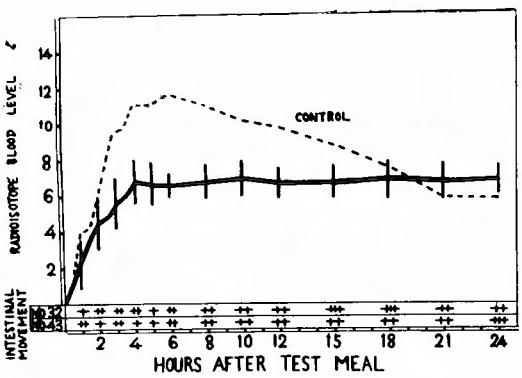

Fig. 11 Graph showing comparison in curve of blood isotope percent in normal and gastrojejunostomized dogs two weeks after operation, and the gastrointestinal motility.

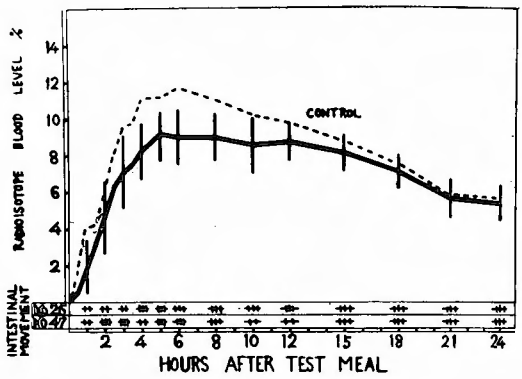

Fig. 12 Graph showing comparison in curve of blood isotope percent in normal and gastrojejunostomized dogs three weeks after operation, and the almost normal mitility of the gastrointestine.

For 3 weeks after operation, five dogs were carefully fed by postoperative diet. Among them, two were arranged plastics windows on the abdominal wall.

The test meal was administered into the stomach through rubber tube. Absorption and the gastrointestinal motility recovered perfectly and the absorption curbe showed almost same trail as control. Adhesion of peritoneum and fluid of exudation were not observed. These results are shown in Fig. 12 and Table 5.

Table 5 Radioisotope blood level (%) and the gastrointestinal motility 3 weeks after gastrojejunostomy

		No. 47 dog 8.7kg		
Time	Blood level (%)	Movement of the intestine		
5′	0	A, 10	B, 9	(frequency/min.)
10′	0.1	A, 12	B, 10	
15′	0.2	A, 13		
30′	0.4		B, 11	
1. 0′	1.2	A, 14	B, 10	
1.30′	1.7	A, 14	B, 14	
2. 0′	3.0	A, 12	B, 13	
2.30′	4.9	A, 12	B, 12	
3. 0′	6.0	A, 11	B, 11	
3.30′	6.4	A, 14	B, 11	
4. 0′	7.9	A, 12	B, 12	
5. 0′	9.1	A, 12	B, 12	
6. 0′	8.2	A, 10	B, 10	
8. 0′	8.5	A, 13	B, 13	
10. 0′	8.0	A, 13	B, 12	
12. 0′	8.1	A, 10	B, 10	
15. 0′	7.1	A, 10	B, 9	
18. 0′	6.4	A, 11	B, 12	
21. 0′	6.1	A, 12	B, 12	
24. 0′	5.8	A, 12	B, 12	

Point A is 20 cm, and Point B is 89 cm distal from the ligament of TREITZ's.

III. Absorption and the gastrointestinal motility after gastrectomy

Partial gastrectomy by BALFOUR's method, modification of BILLROTH 11, was performed on the dogs under general anesthesia by ether and two-third of the stomach was removed. After this treatment the dogs were carefully fed by the postoperative diet.

A. Absorption and the gastrointestinal motility immediately after gastrectomy

When the gastrectmized dogs were awakened from anesthesia, 100 μc of the test meal containing I^{131} labeled olive oil was administered into the stomachs. There were almost perfect absence of absorption and gastrointestinal motility throughout 24 hours period of the test (Fig. 13). The same result was obtained in absorption from the stomach only, so it was supposed that the test meal was stagnated in the stomach for the standstill of the gastrointestinal motility. The data of this experiment are shown in Table 6.

Table 6 Radioisotope blood level (%) immediately after gastrectomy

Time	No. 81 3.0kg Blood level (%)	No. 10 11.2kg Blood level (%)	No. 15 8.8kg Blood level (%)
5′	0	0	0
10′	0.06	0.04	0.03
15′	0.20	0.11	0.02
30′	0.10	0.12	0.01
1. 0′	0.10	0.31	0.08
1.30′	0.20	0.39	0.08
2. 0′	0.20	0.81	0.04
2.30′	0.18	0.79	0.05
3. 0′	0.17	0.71	0.03
3.30′	0.20	0.78	0.02
4. 0′	0.19	0.60	0.02
5. 0′	0.31	0.70	0.03
6. 0′	0.24	0.71	0.06
8. 0′	0.23	0.63	0.08
10. 0′	0.41	0.41	0.11
12. 0′	0.34	0.34	0.12
15. 0′	0.33	0.20	0.14
18. 0′	0.20	0.23	0.09
21. 0′	0.21	0.29	0.10
24. 0′	0.21	0.20	0.10

The movement of the stomach and the intestine were not observed, but sometimes there was the spastic and tonic movement. Gastric tonus was relaxed and the capillary venous stasis of the gastrointestinal serosa was remarkably observed. The fluid of exudation was not seen during the test.

B. Absorption and the gastrointestinal motility 4 days after gastrectomy

Absorption from the gastrointestinal tract and their motility were studied, using gastrectomized dogs. The peristaltic movement of the small bowel was irregular and easily fatigued, because the movement was not yet completely recovered. The maximum value of radioisotope blood content was under 5%, and it took much time to reach the maximum level compared with normal control. This result are shown in Fig. 14 and Table 7.

C. Absorption and the gastrointestinal motility a week and two weeks after gastrectomy

After one week, absorption recovered to a certain degree but the maximum

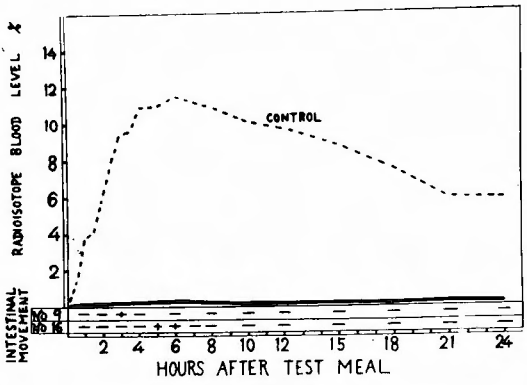

Fig. 13 Graph showing comparison in curve of blood isotope percent in normal and gastrectomized dogs immediatly after operation, and the intestinal motility was not observed during the examination of 24 hours.

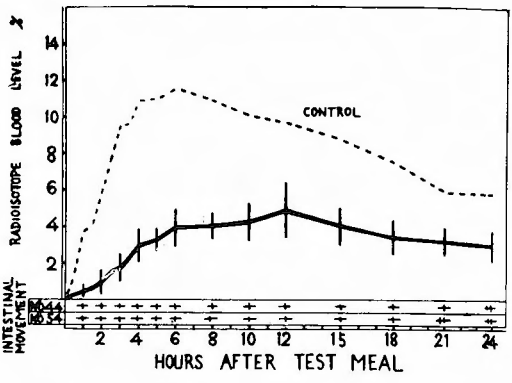

Fig. 14 Graph showing comparison in curve of blood isotope percent in normal and gastrectomized dogs 4 days after operation, and the gastrointestinal motility.

Table 7 Radioisotope blood level (%) and the intestinal motility 4 days after gastrectomy

Time	Blood level	No. 44 dog 8.1kg Intestinal motility
5′	0.03	
10′	0.04	Intestinal motility was observed, but it was easily fatigued.
15′	0.05	
30′	0.07	Peristalsis was irregular and sometimes the movement faded away.
1. 0′	0.14	
1.30′	0.40	Gastric tonus was slightly relaxed and gastric peristalsis was not observed.
2. 0′	0.41	
2.30′	1.21	Intestinal motility was similar to the above.
3. 0′	1.50	
3.30′	1.91	Fluid of exudation was not seen.
4. 0′	1.88	Congestion of capillar vein was observed.
5. 0′	2.14	
6. 0′	2.81	
8. 0′	2.83	Intestinal motility was regular but it was not active.
10. 0′	3.71	
12. 0′	4.50	Gastrointestinal motility was not yet completely recovered.
15. 0′	3.24	
18. 0′	2.62	
21. 0′	2.19	
24. 0′	2.36	

level of radioisotope blood content was still lower than control, and the motility of the gut was not completely recovered. After two weeks, the maximum level reached nearly the same value as that of normal control and was about 8%. It took less time to reach the maximum level than after one week. The results of this test are shown in Fig. 15 and 16, and the data of this experiment are in Table 8 and 9.

The peristaltic movement was rhythmic, but sometimes incomplete. The intervals of it were regular though irregular intervals appeared at times.

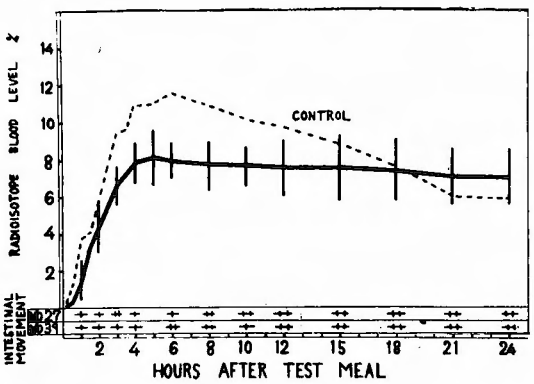

Fig. 15 Graph showing comparis on in curve of blood isotope percent in normal and gastrectomized dogs a week after operation, and the gastrointestinal motility.

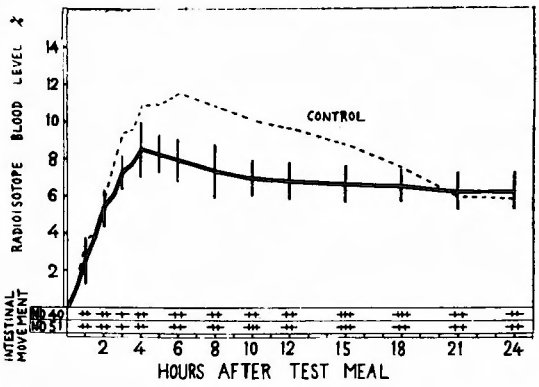

Fig. 16 Graph showing comparison in curve of blood isotope percent in normal and gastrectomized dogs 2 weeks after operation, and the gastrointestinal motility.

Table 8 Radioisotope blood level (%) and the gastrointestinal motility one week after gastrectomy

Time	Blood level	No. 39 dog 9.1kg Motility of the intestine and the stomach
5′	0.03	(frequency/min.)
10′	0.04	Faint peristaltic movement was observed but it was comparatively rythmic, and sometimes spastic movement appeared.
15′	0.10	
30′	0.4	
1. 0′	1.5	The intervals of the movement were very long.
1.30′	3.0	
2. 0′	4.2	Tonus and congestion of capillar vein of the intestinal serosa
2.30′	5.5	was not observed.
3. 0′	7.5	Fluid of exudation was not seen.
3.30′	7.9	
4. 0′	8.3	Faint peristaltic movement was rythmic, but sometimes incom-
5. 0′	8.8	plete movement was still observed.
6. 0′	8.5	
8. 0′	8.4	G. M. 4 I. M. 8
10. 0′	7.9	G. M. 3 I. M. 6
12. 0′	8.1	G. M. 4 I. M. 8
15. 0′	8.0	G. M. 4 I. M. 9
18. 0′	7.7	G. M. 3 I. M. 11
21. 0′	7.6	G. M. 3 I. M. 10
24. 0′	7.4	G. M. 3 I. M. 12

G. M. : gastric movement I. M. : Intestinal motility

D. Absorption and the gastrointestinal motility three weeks after gastrectomy

Using gastrectomized dogs three weeks after operation, the relationship between fat absorption and the gastrointestinal motility was studied. In four tests of eight, the dogs were fixed operatively the plastics windows on the abdominal wall. After three weeks, both fat absorption and the motility of the small gut were almost normal. The results of this experiment are shown in Fig. 17 and Table 10.

During this test the peristaltic movement was rhythmic and active, and it has regular intervals as control. The fluid of exudation, adhesion of the peritoneum and congestion of capillar vein of the intestinal serosa were not seen.

Table 9 Radioisotope blood level (%) and the intestinal motility 2 weeks after gastrectomy

		No. 40 dog 7.1kg		
Time	Blood level	Intestinal motility		
5′	0.04	A, 8	B, 8	(frequency/min.)
10′	0.06	A, 8		
15′	0.4	A, 9		
30′	1.5	A, 8	B, 10	
1. 0′	3.4	A, 10	B, 10	
1.30′	5.2	A, 10	B, 11	
2. 0′	6.0	A, 9	B, 10	
2.30′	7.0	A, 10		
3. 0′	8.5	A, 6		
3.30′	9.2	A, 8	B, 9	
4. 0′	9.9		B, 9	
5. 0′	9.3		B, 7	
6. 0′	9.1	A, 7	B, 8	
8. 0′	8.9	A, 10		
10. 0′	8.0	A, 11		
12. 0′	7.9	A, 12	B, 9	
15. 0′	7.7	A, 12	B, 7	
18. 0′	7.7	A, 10	B, 9	
21. 0′	7.4		B, 12	
24. 0′	7.2	A, 11	B, 10	

Table 10 Radioisotope blood level (%) and the gastrointestinal motility 3 weeks after gastrectomy

		No. 35 dog 8.9kg		
Time	Blood level	Intestinal motility		
5′	0.1	A, 10	B, 10	(frequency/min.)
10′	0.2			
15′	0.2	A, 12	B, 11	
30′	0.5	A, 13	B, 10	
1. 0′	1.4	A, 14	B, 12	
1.30′	2.5		B, 12	
2. 0′	3.0	A, 13	B, 10	
2.30′	4.6	A, 12		
3. 0′	5.7	A, 14		
3.30′	6.8	A, 13	B, 13	
4. 0′	7.9	A, 13	B, 12	
5. 0′	9.0		B, 13	
6. 0′	8.2		B, 13	
8. 0′	7.4	A, 12	B, 13	
10 0′	6.9	A, 14	B, 12	
12. 0′	5.4	A, 13		
15. 0′	5.2	A, 12		
18. 0′	4.9	A, 10	B, 14	
21. 0′	4.7		B, 12	
21. 0′	4.5		B, 12	

Point A is 71 cm and Point B is 39 cm distal from the ligament of Treitz.

IV. Absorption when the test meal was directly administered into the small bowel through WITZEL's enterostomy and the intestinal transport immediately after gastrectomy

It is supposed that the test meal may be stagnated in the stomach immediately after gastrointestinal operation. If this is true, it will be more effective for fat absorption to administrate test meal directly into small bowel. To examine this assumption, the experiment was carried out on gastrectomized dogs with WITZEL's

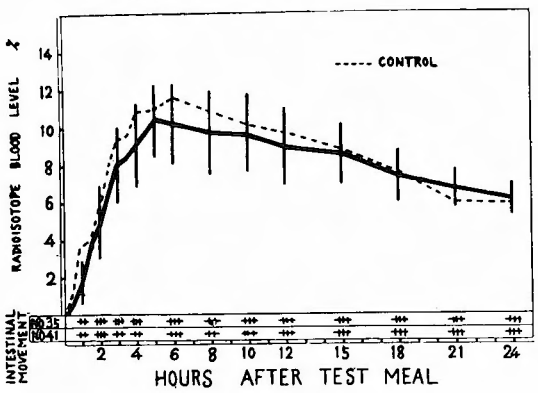

Fig. 17 Graph showing comparison in curve of blood isotope percent in normal and gastrectomized dog 3 weeks after operation, and the gastrointestinal motility was completely recoverd.

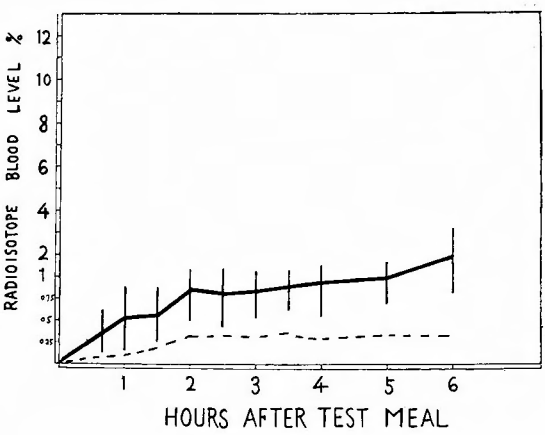

Fig. 18 Graph showing comparison in mean curve of blood isotope percent in gastrectomized only and gastrectomized dogs with WITZEL's enterostomy immediatly after operation. Average curve of gastrectomy only is brocken line at points indicated.

—— The absorption curve of gastrectomy with WITZEL's enterostomy.

····· The absorption curve of gastrectomy without WITZEL's enterostomy.

enterostomy. Fat absorption was not so good as expected, and the maximum value of radioisotope blood content was about 1 per cent. Absorption rate revealed by blood radioisotope per cent was a little better than that of gastrectomized dogs without WITZEL's enterostomy.

In order to observe the transit of intestinal contents ingested directely into the small bowel, Phenol red was used as a marker which was proved to be hardly absorbed by REYNELL and SPRAY.[17] The marker was administered into the small bowel with the test meal. The results of this study are shown in Fig. 18 and Table 11.

Table 11 Radioisotope blood level in gastrectomized dogs with WITZEL's enterostomy

Time	No. 59 dog 9.2kg Blood level (%)	No. 62 dog 8.6kg Blood level (%)	No. 71 dog 12.4kg Blood level (%)
5′	0.02	0.04	0.05
10′	0.06	0.06	0.09
15′	0.32	0.06	0.71
30′	0.45	0.12	0.64
1. 0′	0.67	0.22	0.79
1.30′	0.65	0.39	0.65
2. 0′	0.92	0.42	0.80
2.30′	0.87	0.42	0.67
	1.08	0.45	0.65
3.30′	1.15	0.46	1.13
4. 0′	1.17	0.58	1.09
4.30′	1.18	0.77	1.12
5. 0′	1.23	1.18	1.04
5.30′	1.3	1.38	1.09
6. 0′	1.3	1.74	1.03

After six hours period of the test, the dogs for this experiment were killed by intravenous injection of 0.1% solution of strychnin nitrate. Phenol red was distri-

buted along the intestinal tract and it was transported about 41 cm in No. 59 dog, about 25 cm in No. 62 dog and about 30 cm in No. 71 dog for these six hours.

V. Absorption from the gut without bile

The abdomen was opened by upper abdominal vertical incision and the common bile duct was tightly ligated on ten dogs to prevent bile from flowing into duodenum. Five of ten dogs were performed cholecystostomy so as to bile was discharged outside the body from the end of rubber tube introduced to gall bladder. Two weeks after this operation, the test meal containing radioactive labeled fat was introduced through rubber tube into the stomachs of the dogs. This experiment continued for 24 hour period after administration of the test meal to study fat absorption rate comparing with that of normal dogs.

A. Absorption from the gut without bile after ligation of common bile duct

Ligation of common bile duct resulted in jaundice, and digestion and absorption revealed by blood isotope per cent were impaired remarkably during the period of the test. But the peristaltic movement of the small bowel was comparatively rhythmic and active. The maximum level of blood isotope per cent was under 5 per cent eight hours after administration of the test meal. This results are shown in Fig. 19 and Table 12.

Table 12 Radioisotope blood level and the intestinal motility without bile

		No. 66 dog 8.8kg		
Time	Blood level	Intestinal motility		
5′	0	A, 12	B, 14	(frequency/min.)
10′	0	A, 12	B, 14	
15′	0.53	A, 14	B, 10	
30′	0.67	A, 14	B, 11	
1. 0′	0.66		B, 12	
1.30′	0.84	A, 10		
2. 0′	1.13	A, 12		
2.30′	1.72	A, 12		
3. 0′	3.22	A, 10	B, 13	
3.30′	4.00		B, 14	
4. 0′	5.01		B, 12	
5. 0′	4.68	A, 13	B, 13	
6. 0′	4.80	A, 13	B, 14	
8. 0′	4.80	A, 11		
10. 0′	4.32	A, 9		
12. 0′	5.24	A, 11		
15. 0′	4.97	A, 10		
18. 0′	4.85		B, 13	
21. 0′	4.65		B, 14	
24. 0′	4.43		B, 12	

Point A is 63 cm, and Point B is 79 cm distal from the ligament of TREITZ.

After two weeks, MEULENGRUCHT'S index was 56 in No. 66 dog.

B. Absorption from the gut after bile was discharged outside the body

As the result of ligation of common bile duct, jaundice was caused and fat absorption was seriously impaired. So, this time bile was excluded outside the body through rubber tube. After two weeks, the rate of radioactive labeled fat entering into blood was studyed. It was better than when cholecystostomy was not performed. The maximum level of blood isotope per cent was above 8% 4 hours after administration of the test meal. From this results, it is supposed that jaundice

exerted an evil influence upon fat absorption. The results of this test are shown in Fig. 20 and Table 13.

The peristaltic mevement was rythmic and active and gastric strain was normal. The interval of the movement was regular. It was recognized that the gastrointestinal movement was fully recovered. MEULENGRUCHT's index was 1.7 in No. 85 dog two weeks after the ligation.

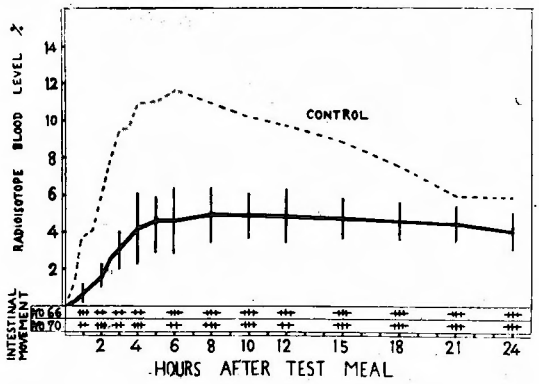

Fig. 19 Graph showing comparison in mean curve of blood isotope percent in normal and bile duct occluded dogs without cholecystostomy, and the gastrointestinal motility was active as normal control.

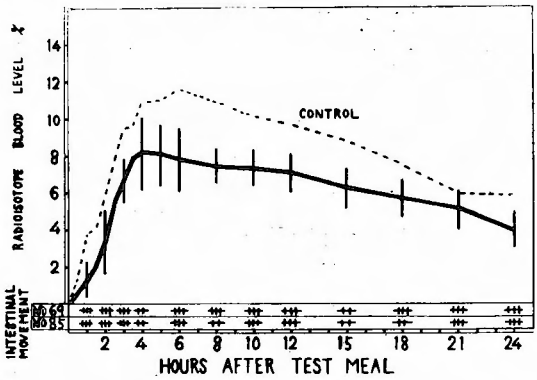

Fig. 20 Graph showing comparison in mean curve of blood isotope percent in normal and bile duct occluded dogs with cholecystostomy, and the gastrointestinal motility was active as normal control.

Table 13 Radioisotope blood level (%) and the intestinal motility after bile was excluded outside the body with cholecystostomy

		No. 85 dog 7.9kg			
Time	Blood level (%)	Intestinal motility			
5′	0	A, 12			(frequency/min.)
10′	0.09				
15′	0.28	A, 14		B, 13	
30′	0.59	A, 14			
1. 0′	1.41	A, 13		B, 12	
1.30′	2.09	A, 12		B, 14	
2. 0′	3.48	A‘ 14		B, 13	
2.30′	5.86				
3. 0′	6.38	A, 10			
3.30′	7.00	A, 14		B, 12	
4. 0′	7.70	A, 11		B, 13	
5. 0′	8.11			B, 12	
6. 0′	8.19			B, 11	
8. 0′	7.54	A, 12		B, 13	
10. 0′	7.08	A, 12		B, 13	
12. 0′	6.83	A, 14			
15. 0′	5.37	A, 13			
18. 0′	5.60	A, 13			
21. 0′	5.00	A, 13			
24. 0′	3.61	A, 12			

Point A is 92 cm, and Point B is 41 cm distal from the ligament of TREITZ.

DISCUSSION

The problem concerning with fat absorption after gastrointestinal surgery has been studied by many investigators.[18),19),20),21),22)] However, their studies were only by means of the quantitive analysis of fat in feces. Since the technique of the research of Radioisotope tracer-method was contrived by HEVESY[23),24)] in 1923, the application of this technique to the medical field has made the investigation more simplified, but few of their investigators have paid any attention to the gastrointestinal motility. In 1958, using I^{131} labeled casein, NAITO[3)] reported the study on the relationship between the gastrointestinal motility and protein absorption after gastrointestinal surgery, and he clarified that protein absorption had some relation not only to the gastrointestinal motility but also to various factors such as temperature, blood circulation, secretion of digestive juice and enzyme activity. SHINGLETON and his coworkers,[25),26),27),28)] using I^{131} labeled glycerol trioleate, reported clinically and experimentally studies on the absorption of fat from the gut in the patients of biliary, pancreatic and small intestinal disorders compared with the normal control group, and they indicated that the pancreatic juice played a major role, but the bile played a minor one in the digestion and absorption of fat.

In this experiment, fifteen dogs of both sexes were used to obtain a normal control value of blood radioisotope content when the test meal was administered into the stomach through a gastric tube. The absorption curve obtained nearly the same as that obtained by SHINGLETON,[27)] but the absorption rate was somewhat lower, and maximum level was about 2% lower compared with that of SHINGLETON. The difference between these two data would be attributed to the properties of the test meal used, whether it was emulsified or unemulsified fat.

With regard to the absorption of foods from the stomach when the pylorus was occluded, SHINGLETON and NAITO recognized that protein was not absorbed at all from the stomach during the examination of 24 hours. In the present experiment, the absorption of fat from the stomach was confirmed to be almost absent, as reported by SHINGLETO and NAITO in protein absorption. And also, it is readily recognized that the stomach has no function on fat digestion and absorption. However, when the test meal was introduced directly into duodenum which was exposed operatively under a local anethesia, the value of radioisotope blood content increased more rapidly, but the maximum level was somewhat lower than the control value, and thereafter it decreased comparatively rapidly. This result shows that fat absorption do not be enhanced by abnormally rapid transit time through the gut. Therefore, it is considered that the intestinal content may passed through the duodenal canal before the test meal is mixed with the pancreatic juice which, otherwise, may not be secreted enough to digest the most of the test meal ingested.

As described above, fat absorption is influenced not only by the gastrointestinal motility but also by various factors such as blood supply, production and secretion of digestive juice and enzyme activity. However, it is not yet understood that how much these factors have the influence upon the vital function of the intestinal mucous membrane. Recently, it was supposed that fat was absorbed after the

hydrolysis into glycerol and fatty acid by the digestive juice under the special vital function of intestinal mucous membrane. In this experiment, a small quantity of 0.01 mol solution of monojodoacetic acid was added to the test meal as an enzyme inhibitor, and it was introduced into the stomach or directly into the duodenum of experimental animals. Then, the digestion and absorption of fat were impaired and showed a characteristic absorption curve, even though the gastrointestinal motility was so active as that of normal control. This result indicates that fat absorption is greatly influenced by the absorptive function of the intestinal mucous membrane as well as intestinal transit. When the state of the gut is not physiological like the standstill of the gastrointestinal motility, it is considered that the absorption is influenced not only by the intestinal transport but also by the disturbance of vital function of intestinal mucous membrane. It was already reported by ASANO[1] and NAITO[3] that digestion and absorption is greatly influenced by monojodoacetic acid.

Absorption from the gut without bile which plays some role in fat digestion was studied in dogs by means of the ligation of the common bile duct. Namely, the study in ligated dogs with cholecystostomy showed no remarkable impdiment of fat digestion and absorption, but without cholecystostomy showed a conspicuous impairment of absorption, and the absorption curve showed considerable difference between ligated dogs with and without cholecystostomy. Jaundice was appeared in dogs with the ligation of the common bile duct and without cholecystostomy, and fat absorption was inhibited supposedly by the disturbance of the liver function. From this experiment, it has been recognized that bile plays not so important role in fat digestion and absorption.

With regard to the absorption under a general anesthesia by ether, NAITO[3] reported that protein absorption was very little during the anesthesia, and after the anesthesia, protein absorption was inhibited a long time inspite of the recovery of the gastrointestinal motility. In this experiment, as I^{131} labeled olive oil as the test meal was administered into the stomach and the duodenum in dogs, fat absorption was entirely absent during the anesthesia, and after it, absorption was gradually regained in parallel with the recovery of the gastrointestinal motility, but it was extremely restrained for a long time even after the recovery of the gastrointestinal motility. As reported by NAITO[3] in protein absorption, it is confirmed that fat absorption is also inhibited not only by the distribution of the intestinal content along the intestinal tract but also by various factors such as the production and secretion of digestive juice, blood circulation, enzyme activity and physiologic function of intestinal mucous membrane.

Immediately after a gastroenterostomy or partial gastrectomy, no gastrointestinal motility was observed except the pendulous movement of the small bowel occasionally and faintly observed, because the region of a gastroenterostomy showed an abnormal condition such as congestion and stasis of regional vesseles, edema and spasm at the site of anastomosis. Moreover, as reported by ASANO[1] in the study of absorption of P^{32}, the intestinal content is not transported until the ileocecal region within 24 hours after ingestion. Immediately after a gastroenterostomy or a

partial gastrectomy, fat absorption was not observed during the examination, as studied in dogs with pyloric obstruction. Because, the test meal is stagnated in the stomach by the standstill of the gastrointestinal motility. Therefore, it is supposed that fat absorption is vigorous when the test meal is administered directly into the small bowel. To prove this supposition, the experiment was carried out on the gastrectomized dog with a jejunal fistula. However, fat absorption is not so good as previously expected. In order to observe the transit of the intestinal content administered directly into the small bowel, phenol red was administered through WITZEL's jejunal fistula with the test meal. Phenol red was distributed along the intestinal tract and transported about 35 cm six hours after ingestion, namely, the transport of the test meal was remarkably delayed.

Recently, many investigators have advocated the early feeding after gastrointestinal surgery to initiate the administration of the liquid diet directly into the small bowel through MÜLLER-ABBOTT's double tube so early as the first operative day. However, it will be uncertain how much of the diet administered can be absorbed during the first 24 hours after surgery, in as far as the gastrointestinal motility is usually not yet reappeared during this period. If the early feeding is enforced in such a state, nausea, vomiting and the abdominal distension will ensue. Even after four days postoperatively, the gastrointestinal motility was not yet recovered completely and also fat absorption was considerably disturbed compared with the normal control; the motility was easily fatigued and irregular, and occasionally, even the spastic and tonic movement was observed, and the absorption rate was under half of control and more time was taken to reach the maximum level than control. But after one to two weeks, the gastrointestinal motility and fat absorption were gradually recovered as time elapsed, and after three weeks, they showed no remarkable differences between the control and dogs with gastroenterostomy or gastrectomy. From these experiments, it is recognized that fat absorption related to the gastrointestinal motility after gastrointestinal surgery, and it will be considered that the vital function of the intestinal mucous membrane, which has much influences upon fat digestion and absorption, is regained in parallel with the recovery of the motility. In conclusion, from the physico-chemical standpoint on the early feeding by mouth, the diet should be initiated under the consideration of the gastrointestinal motility which is one of the most important indicators for digestion and absorption.

SUMMARY AND CONCLUSION

The study on the relationship between the gastrointestinal motility and fat absorption has been performed on dogs after gastrointestinal surgery. The digestion and absorption of the test meal containing radioactive labeled fat is evaluated by the measurement of the percentage of I^{131} labeled fat in blood with the periodic intervals up to 24 hours following administration of the test meal. Furthermore, studies on fat absorption from the different region of the gastrointestine and on the influence of anethesia and enzyme inhibitor upon the absorption have been done as the preliminary experiment. The gastrointestinal motility was observed through the

plastics window which was operatively fixed on the abdominal wall of the experimental animals. The results are as follows:

1) The test meal was administered into the fasty stomach of dogs and the absorption curve was determined, in which it was clarified that the level reached to maximum at about six hours after the ingestion.

2) Digestion and absorption of I^{131} labeled fat were not observed in the stomach of dogs with pyloric obstruction during the examination of 24 hours. However, when the test meal was introduced directly into the duodenum, it took less time to reach the maximum level but the maximum value was a little lower than control.

3) When the test meal with 0.01 mol solution of monojodoacetic acid was administered into the stomach or directly into the duodenum, the absorption was remarkably restrained even though the gastrointestinal motility was active.

4) With regard to fat absorption from the gut without bile after the ligation of common bile duct, the absorption curve shows the significant difference between ligated dogs with and without cholecystostomy, namely, it was recognized that the bile plays less important role in fat digestion and absorption, and the liver function has a great influence on them.

5) When the test meal is administered into the stomach and directly into the duodenum under the general anesthesia by ether, fat absorption is strongly disturbed, and after the anesthesia the absorption has been inhibited for a long time even after the complete recovery of the gastrointestinal motility.

6) Immediately after gastroenterostomy or partial gastrectomy, the gastrointestinal motility is not recognized and fat absorption is also entirely impaired during the examination.

7) When the test meal is introduced into the small intestine through WITZEL's jejunal fistula immediately after gastrectomy, fat absorption is not so good as previously expected and the intestinal transit is extremely delayed.

8) Four days, a week and two weeks after gastroenterostomy or partial gastrectomy, the gastrointestinal motility and fat absorption are not yet recovered completely, and the absorption rate is lower than control. But as time elapsed, the absorption is gradually recovered in parallel with the recovery of the gastrointestinal motility.

9) After three weeks, the gastrointestinal motility is already active and the absorption curve shows almost same trail as control.

10) These data revealed that, after gastrointestinal surgery, fat absorption is intimately concerned with the gastrointestinal motility.

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Bibliography

1) Asano, Y.: Gastrointestinal Movements and Absorption after Abdominal Operation (studied with isotopeP ^{32}). Arch. Jap. Chir., **26**, 396, 1957.
2) Watanabe, Y.: The Experimental Study on the Relation between the Gastrointestinal Movements and the Absorption of Radioactive Sodium, with Special Reference to the Gastrointestinal Operation. Arch. Jap. Chir., **26**, 532, 1957.
3) Naito Y.: The Experimental Study on the Relation between the Gastrointestinal Movements and the Absorption of the Protein after Gastrointestinal Surgery, Using the Radioactive Iodocasein. Arch, Jap. Chir., **28**, 205, 1959.
4) Harry J. and Deuel, Jr.. Fat as a Required Nutrient of the Diet; Symposium on Lipids in Nutrition. Federation Proc., **14**, 639, 1955.
5) Gorens, S. W., Geyer, R. P., Matthews, L. W. and Stare, F. J.: Parenteral Nutrition. X. Observation the Use of a Fat Emulsion for Intravenous Nutrition in Man. J. Lab. and Clin. Med., **34**, 1627, 1949.
6) Hikasa, Y., Asada, S., Zaitsu, A., Tsukada, A. and Nakata, K.: Studies on the Intravenous Administration of Fat Emulsion. Arch. Jap. Chir., **21**, 1, 1952.
7) Kuyama Takeshi: Clinical Studies on the Nutritional Effects of Intravenous Administration of Fat Emulsion. Arch. Jap. Chir., **27**, 64, 1958.
8) Miyakawa, Y. and Miyakawa, I.: A Experimental Study on the Intravenous Administration of Fat Coloid Glucosis. Sogo-Igaku, **7**, 1159, 1950.
9) Komi, N.: A Study on Tube Feeding Using Fat Emulsion. J. Jap. Surgical Society, **59**, 657, 1957.
10) Hosaka, T.: A Study of Fat Absorptive Function, Especially its Relation to Intestinal Motility after Removal of Ileocecal Area by Means of Fat-Barium-Meals. J. Jap. Surgical Society, **57**, 1673, 1957.
11) Nakayama, K.: Digestion and Absorption Following Gastrointestinal Surgery. J. Jap. Surgical Society, **59**, 972, 1958.
12) Tomoda, M.: Operation on the Alimentry Tract and the Postoperative Degestion and Absorption, with Particular Reference to the Problems of Metabolism in Total Gastrectomized Patients. J. Jap. Surgical Society, **59**, 990, 1958.
13) Hoffman, M. C.: Radioactive Iodine Labeled Fat. J. Lab. & Clin. Med., **41**, 521, 1953.
14) Hamilton C. F., Marchelle H. Power and Albert A.: Preparation of Radioactive Iodocaseine. J. Biol., Chem., **178**, 213, 1949.
15) Naito Y. and K. Masuda: The Synthesis of Radioactive Iodocasein and Radioactive Iodo-olive oil. Juntendo Med., **3**, 140, 1957.
16) Tanaka K.. Studies on the Gastrointestinal Movement after Operation Using Abdominal Window. J. Jap. Surgical Society, **35**, 185, 1934.
17) Reynell P. C. and G. H. Spray: The Simultaneous Measurement of Absorption and Transit in the Gastro-intestinal Tract. J. Physiol., **131**, 452, 1955.
18) Hushang Javid: Nutrition in Gastric Surgery with Particular Reference to Nitrogen and Fat Assimilation, Surgery, **38**, 641, 1955.
19) Wollaeger, E. E.: Disturbance of Gastrointestinal Function Following Partial Gastrectomy Postgrad. Med., **8**, 251, 1950.
20) Wollaeger, E. E., Comfort, M. W. and Osteberg, A. E.: Total Solids, Fat and Nitrogen in the Feces. A Study of Normal Persons Taking a Test Diet Containing a Moderate Amount of Fat; Comparison with Results Obtained with Normal Persons Taking Diet Containing a Large Amount of Fat. Gastroenterology, **9**, 272, 1947.
21) Wollaeger, E. E., Comfort, M. W., and Weir J,. F.: The Total Solids, Fat and Nitrogen in the Feces: A Study of Person hho Had Undergone Partial Gastrectomy with Anastomosis of the Entire Cut End of the Stomach and the Jejunum (Polya Anastomosis). Gastroenterologyr, **6**, 93, 1946.
22) Browne C. D., and Mc Hardy, C.: The Patient after Gastric Surgery. South M. J. **36**, 32, 1943.
23) Hevesy, G.: A Contribution to the Application of the Method of Radioactive Indicators in

the Investigation of the Change of Substance in Plants. Biochem. J. **17**, 29, 1923.
24) Hevesy G.: Radioactive Indicators their Application in Biochemistry. New York, 1948.
25) Baylin G. J., A. P. Sander, J. K. Isley, W. W. Shingleton, J. C. Hymans, D. H. Johnston and J. M. Ruffin: I^{131} Blood Levels Correlation with Gastric Empting Determined Radiographically. I. II. Proc. Soc. Exper. Biol. & Med. **89**, 51, 1955.
26) Shingleton, W. W., M. D., George J. Baylin, M. D., Joseph, K. Isley, M. D. ArRon P. Sanders, M. S., Julian M. Ruffin, M. D.: A Study of Fat Absorption after (Gastric Surgery Using I^{131} Labeled Fat. Ann. Surgery, **144**, 433, 1956.
27) Shingleton, W. W., M. H. Wells G J. Baylin, J. M. Ruffin and A. Sanders: The Use of Radioactive-Labeled Protein and Fat in the Evaluation of Pancreatic Disorders. Surgery, **38**, 134, 1955.
28) Wells, M. H., W. W. Shingleton and A. P. Sanders: Absorption in Dogs Following Exclusion of Bile and Pancreatic Juice Using I-Labeled Fat(22147). Proc. Soc. Exper. Biol. and Med., **90**, 717, 1955.

和 文 抄 録

放射性ヨード標識オレーフ油使用による胃腸手術後の胃腸運動と脂肪吸収との関係に就ての実験的研究

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胃腸手術後の吸収，特に高カロリーを有する脂肪の吸収は，術後栄養の問題と関連して益々重視されて来ている．

成犬を用い，胃腸運動を腹窓法により観察し，I^{131} 標識オレーフ油を使用して胃腸手術後の胃腸運動と脂肪吸収の関係を研究し，加えるに，胃腸管各部位からの吸収，更に麻酔及び酵素阻害の吸収に及ぼす影響に就て研究し，次の如き結果を得た．

1) 正常空腹時に於けるI^{131}-オレーフ油の吸収は，胃内注入後約6時間で最高値に達し，その後は漸次下降する．

2) 幽門を閉塞せし場合の胃の中よりのI^{131}-オレーフ油の吸収は全く見られず，一方十二指腸内に直接注入せし場合は，急峻なる吸収曲線を示したが，最高吸収率は対照より低かつた．

3) 0.01モルのモノヨード醋酸により，胃腸運動は良好であるにも拘らず，I^{131}-オレーフ油の吸収は著るしく抑制された．

4) 総輸胆管を結紮し，胆汁の十二指腸への流出を阻止せし場合のI^{131}-オレーフ油の吸収に就ては，胆嚢切開術を施行せしもの及びせざるものとの間に著明なる相異を示し，即ち，前者は比較的良好なる吸収を示したが後者は吸収の著るしい障害を示した．

5) エーテル全麻中は胃腸運動及びI^{131}-オレーフ油の吸収は殆んど認められず，麻酔終了後は，胃腸運動が完全に恢復したのに拘わらず，吸収は長時間に亘つて抑制された．

6) 胃腸吻合術及び胃切除術(以後胃腸手術と略す)の直後では，正常胃腸運動は認められず吸収も全く見られなかつた．

7) 胃切除術直後ウッツエル氏腸瘻より試験食を注入せし場合，期待した程その吸収は良好でなかつた．

8) 胃腸手術より4日経過後では，胃腸運動及び吸収は甚だ悪く，吸収率は対照の50%以下であつた．実に術後1及び2週間経過後では，胃腸運動及び吸収は日数の経過と共に次第に恢復せるも，その吸収率は対照より劣つた．

9) 胃腸手術より3週間経過後では，胃腸運動は完全に恢復し吸収率は対照と同じ値を示した．

10) 胃腸手術後，脂肪の吸収は胃腸運動と密接なる関係があることを知つた．